

AMENDMENTS TO THE CLAIMS

The listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS

1. (Currently Amended) A method of processing signals received from an array of sensors comprising ~~the steps of~~:

sampling and digitally converting the received signals and;
processing the digitally converted signals to provide an output signal, the
processing including filtering the signals using a first adaptive filter arranged to enhance
that enhances a target signal of the digitally converted signals and a second adaptive filter ~~arranged to suppress~~ that suppresses an unwanted signal of the digitally converted signals, and processing the filtered signals in ~~the~~ a frequency domain to further suppress the unwanted signal ~~further~~:

determining a direction of arrival of the target signal; and
treating a signal of the received signals as an unwanted signal if the signal has
not impinged on the array from within a selected angular range.

Claim 2 (Canceled).

3. (Currently Amended) A method ~~as claimed in claim 2~~ of processing signals received from an array of sensors comprising:

sampling and digitally converting the received signals;
processing the digitally converted signals to provide an output signal, the
processing including filtering the signals using a first adaptive filter that enhances a
target signal of the digitally converted signals and a second adaptive filter that

suppresses an unwanted signal of the digitally converted signals, and processing the filtered signals in a frequency domain to further suppress the unwanted signal; and determining a signal energy from the received signals and determining a noise energy from the signal energy;

wherein the signal energy is determined by buffering N/2 samples of the digitized signal into a shift register to form a signal vector of the following form:

$$X_r = \begin{matrix} X(0) \\ X(1) \\ \vdots \\ X(J-1) \end{matrix}$$

Where J = N/2; and estimating the signal energy using the following equation:

$$E_r = \frac{1}{(J - 2)} \sum_{i=1}^{J-2} X(i)^2 - X(i+1) X(i - 1)$$

where E_r is the signal energy.

4. (Currently Amended) A method ~~as claimed in claim 2 of processing signals received from an array of sensors comprising:~~

sampling and digitally converting the received signals;
processing the digitally converted signals to provide an output signal, the processing including filtering the signals using a first adaptive filter that enhances a target signal of the digitally converted signals and a second adaptive filter that suppresses an unwanted signal of the digitally converted signals, and processing the filtered signals in a frequency domain to further suppress the unwanted signal; and

determining a signal energy from the received signals and determining a noise energy from the signal energy;

wherein the noise energy is determined by measuring the signal energy E_r of blocks of the digitally converted signals and calculating the noise energy E_n in accordance with

$$E_n^{K+1} = E_n^K + (1 - \alpha) E_r^{K+1}$$

Where the superscript K is the block number and α is an empirically chosen weight.

5. (Currently Amended) A method as claimed in claim 2 1 further comprising ~~the steps of:~~

determining a signal energy from the received signals and determining a noise energy from the signal energy;

determining a noise threshold from the noise energy; and

updating the noise energy and the noise threshold when the signal energy is below the noise threshold.

6. (Currently Amended) A method as claimed in claim 5 further comprising ~~the step of~~ determining if a target signal is present by comparing the signal energy to a signal threshold.

7. (Currently Amended) A method as claimed in claim 6 further comprising ~~the step of~~ determining the signal threshold from the noise energy and updating the signal threshold when the signal energy is below the noise threshold.

8. (Currently Amended) A method as claimed in claim 5 wherein the noise threshold T_{n1} is determined in accordance with:

$$T_{n1} = \delta_1 E_n$$

Where δ_1 is an empirically chosen value and E_n is the noise energy.

9. (Previously Presented) A method as claimed in claim 5 6 wherein the noise signal threshold T_{n2} is determined in accordance with:

$$T_{n2} = \delta_2 E_n$$

Where δ_2 is an empirically chosen value and E_n is the noise energy.

Claims 10-13 (Canceled).

14. (Currently Amended) A method as claimed in claim 11 1 further comprising the step of:

processing the signals from two space sensors of the array with a third adaptive filter to determine the direction of arrival; and
calculating a measure of reverberation of the signal from filter weights of the first and third adaptive filters.

15. (Currently Amended) A method as claimed in claim 14 wherein the reverberation measure C_{rv} is calculated in accordance with

$$C_{rv} = \frac{W_{td}^T W_{su}}{\|W_{td}\| \|W_{su}\|}$$

where T denotes the transpose of a vector, W_{su} is the a filter coefficient of the first filter and W_{td} is the a filter coefficient of the third filter.

16. (Currently Amended) A method as claimed in claim 14 further comprising the step of treating the signal as an unwanted signal if when the reverberation measure indicates a degree of reverberation in excess of a selected value.

Claim 17 (Canceled).

18. (Currently Amended) A method as claimed in claim 1 wherein the first adaptive filter has a plurality of channels, comprising a plurality of difference signal channels, the plurality of channels receiving as input, the digitized signals and providing as output, a sum and at least one difference signal, the difference signal channels including filter elements having corresponding filter weights.

19. (Currently Amended) A method as claimed in claim 18 further comprising ~~the step of calculating a ratio of the energy in the sum and difference channels.~~

20. (Currently Amended) A method as claimed in claim 19 further comprising ~~the step of treating the signal as including a said target signal if the ratio indicates that the energy in the sum channel is greater than the energy in the difference channels by more than a selected factor.~~

21. (Currently Amended) A method as claimed in claim 20 further comprising ~~the step of treating the signal as including a said target signal only if the signal energy exceeds a threshold.~~

22. (Currently Amended) A method as claimed in claim 1 further comprising ~~the step of controlling the operation of the second filter to perform adaptive filtering only when a said target is deemed not to be present.~~

23. (Currently Amended) A method as claimed in claim 1 wherein the first second adaptive filter has a plurality of channels, comprising a plurality of difference signal channels, the plurality of channels receiving input signals from the first adaptive filter and providing as output, a sum signal received from the first adaptive filter, an error signal and at least one a plurality of difference signal signals, the difference signal channels including further filter elements having corresponding further filter weights.

24. (Currently Amended) A method as claimed in claim 23 further comprising the step of scaling the further filter weights if when the norms of the further filter weights exceed a threshold.

25. (Currently Amended) A method as claimed in claim 23 further comprising the step of combining the sum signal and the error signal to form a single signal S(t) of the form:

$$S(t) = W_1 S_c(t) + W_2 e_c(t)$$

where $S_c(t)$ is the sum signal at time t, $e_c(t)$ is the error signal at time t and W_1 and W_2 are weight values.

26. (Currently Amended) A method as claimed in claim 25 further comprising the step of combining the difference signals to form a single signal.

27. (Currently Amended) A method as claimed in claim 25 further comprising the step of applying a Hanning window to the single signals signal.

28. (Currently Amended) A method as claimed in claim 1 further comprising the step of transforming the filtered signals into two frequency domain signals, a desired signal S_f and an interference signal I_f , processing the transformed signals to provide a gain for the desired signal and transforming the gain modified desired signal back to the time domain to provide an output.

29. (Currently Amended) A method as claimed in claim 28 wherein the processing step comprises the step of forming spectra for the frequency domain signals.

30. (Currently Amended) A method as claimed in claim 29 wherein the spectra are modified spectra P_s , P_i of the desired signal and the interference signal of the form:

$$P_s = |\text{Real } (S_f)| + |\text{Imag } (S_f)| + F(S_f) * r_s$$

$$P_i = |\text{Real } (I_f)| + |\text{Imag } (I_f)| + F(I_f) * r_i$$

Where "Real" and "Imag" refer to taking the absolute values of the real and imaginary parts, r_s and r_i are scalars and $F(S_f)$ and $F(I_f)$ denotes a function of S_f and I_f respectively.

31. (Original) A method as claimed in claim 30 wherein the function is a power function.

32. (Currently Amended) A method as claimed in claim 31 wherein the spectra are of the form, ~~where "Conj" denotes the complex conjugate:~~

$$P_i = |\text{Real } (I_f)| + |\text{Imag } (I_f)| + (I_f * \text{conj}(I_f)) * r_i$$

$$P_s = |\text{Real } (S_f)| + |\text{Imag } (S_f)| + (S_f * \text{conj}(S_f)) * r_s$$

where "Conj" denotes the complex conjugate.

33. (Currently Amended) A method as claimed in claim 30 wherein the function is a multiplication function.

34. (Currently Amended) A method as claimed in claim 33 wherein the spectra are of the form:

$$P_s = |\text{Real } (S_f)| + |\text{Imag } (S_f)| + |\text{Real } (S_f)| * |\text{Imag } (S_f)| * r_s$$

$$P_i = |\text{Real } (I_f)| + |\text{Imag } (I_f)| + |\text{Real } (I_f)| * |\text{Imag } (I_f)| * r_i$$

35. (Currently Amended) A method as claimed in claim 29 wherein the processing step includes ~~the step of~~ warping the signal and interference spectra into a Bark scale to form a corresponding signal and interference Bark spectra.

36. (Currently Amended) A method as claimed in claim 35 wherein the processing step further includes ~~the step of~~ calculating a system noise Bark spectrum.

37. (Currently Amended) A method as claimed in claim 36 further comprising the step of combining the interference Bark spectrum and the system noise Bark spectrum to form a combined noise Bark spectrum.

38. (Original) A method as claimed in claim 37 wherein the combined noise Bark spectrum B_y is of the following form:

$$B_y = \Omega_1 B_i + \Omega_2 B_n$$

where Ω_1 and Ω_2 are weighting values B_i is the interference Bark spectrum and B_n is the system noise Bark spectrum.

39. (Currently Amended) A method as claimed in claim 29 further comprising the step of calculating a signal to noise ratio from the spectra and deriving the gain from the signal to noise ratio.

40. (Currently Amended) A method as claimed in claim 39 further comprising the step of modifying the signal to noise ratio with a scaling factor which gradually increases from a first value, at onset of the signal, to a second value as the signal continues, until the signal ceases at which time, wherein the scaling factor is reset to the first value after the signal is received.

41. (Original) A method as claimed in claim 40 wherein the scaling factor changes in a plurality of steps.

42. (Previously Presented) A method as claimed in claim 40 wherein the scaling factor changes exponentially.

Claims 43-46 (Canceled).